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1993-94 School Year

Biology 30, Chemistry 30, Physics 30

Information Bulletin

Diploma Examinations Program

CANADIANA
OCT 13 1993

Students First!
Student Evaluation

Alberta
EDUCATION

This document was written primarily for:

Students	
Teachers	✓
Administrators	
Parents	
General Public	
Others (Specify)	

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SCIENCES DIPLOMA EXAMINATIONS UPDATE FOR 1994

The following information has been updated for teachers and students of Biology 30, Chemistry 30, and Physics 30:

- 1994 Grade 12 Diploma Examinations Schedule
- 1994 Marking Information
- 1993–94 Field Testing and Item Writing

1994 Grade 12 Diploma Examinations Schedule

The 1994 sciences diploma examinations will be administered as follows:

Thursday, Jan. 27	Physics 30	9 to 11:30 a.m.
	Biology 30	1 to 3:30 p.m.
Friday, Jan. 28	Chemistry 30	1 to 3:30 p.m.
Friday, June 24	Physics 30	9 to 11:30 a.m.
Monday, June 27	Biology 30	9 to 11:30 a.m.
Tuesday, June 28	Chemistry 30	9 to 11:30 a.m.
Tuesday, Aug. 16	Chemistry 30	1 to 3:30 p.m.
Wednesday, Aug. 17	Biology 30	9 to 11:30 a.m.
Thursday, Aug. 18	Physics 30	9 to 11:30 a.m.

Note: The diploma examinations are designed as 2.5 hour examinations. It is expected that this is adequate time for students to finish. However, for those students who need it, an extra 0.5 hour is available.

1994 Marking Information

The written-response portion of the sciences diploma examinations is marked by classroom teachers. To qualify as markers, teachers must

- be recommended by their superintendents,
- have taught the subject for two or more years,
- be currently teaching the subject, and
- have an Alberta Permanent Professional Certificate.

We particularly need teachers who can mark examinations written in French.

Teachers who wish to be recommended as markers for the January 1994 examinations should contact their superintendents before October 1, 1993. Teachers who wish to be recommended as markers for the June and August 1994 examinations should contact their superintendents before March 1, 1994.

Marking of the 1994 diploma examinations will take place on the following dates:

Biology 30 • Chemistry 30 • Physics 30	
January Administration	Jan. 31 to Feb. 5
June Administration	July 4 to 9
August Administration	August 19 to 20

1993–94 Field Testing and Item Writing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Teachers who are interested in these activities should let their superintendents know early in the school term.

GENERAL INFORMATION

Format of the Sciences Examinations

The time allotted to write the diploma examinations is two and one-half hours. An additional 30 minutes is available for all students, giving them up to three hours to complete the examinations. All examinations in the three sciences have both machine-scorable questions and written-response questions.

The machine-scorable questions are multiple-choice and, for Chemistry 30 and Physics 30, numerical-response. Please refer to the chemistry and physics sections of this bulletin for further details about numerical-response questions.

A separate data booklet is provided for the Chemistry 30 and Physics 30 examinations. All examinations in the three sciences have tear-out pages for rough work.

Note: The diploma examinations in the sciences contain questions that require students to synthesize concepts from more than one unit of study.

Use of Scientific Calculators on Examinations

The term *scientific calculator* includes all hand-held devices designed for mathematical computation. These scientific calculators may have graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students.

Please refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations and consult the appropriate subject section. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing their examinations.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see Appendix B of this bulletin), one of which states that notes stored in electronic devices may not be brought into the examination room.

Assessment of Written Communication Skills

The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific. Examples of questions, answers, and scoring guides are given in the subject-specific sections of this bulletin.

Standards

Standards in education are statements that communicate the level of performance necessary to attain a specific goal or objective. Statements of standards assist educators in determining the extent to which students must know the content and demonstrate the required skills to pass the course.

Standards for the diploma examination are discussed at the beginning of each specific science section of this bulletin. These standards are applicable to students who attain the *acceptable* standard (a final mark of 50% or higher) and to students who attain the standard of *excellence* (a final mark of 80% or higher).

Examiners' Reports

Following the administration of the January and June examinations, examiners' reports are released. These reports briefly outline the statistical data obtained from the examination administration and provide a diagnostic overview of student performance. Examiners' reports are designed for teacher use. If we can make these reports more useful to you, please let us know. You can reach our examination managers at 427-0010 or by writing to us in care of

Assistant Director
Mathematics/Sciences
Student Evaluation Branch
Alberta Education
Box 43, 11160 Jasper Avenue
EDMONTON, Alberta
T5K 0L2 FAX: 422-4200

School and Jurisdiction Statistical Reports

We send superintendents and principals detailed statistical reports on how well the students in their school district did on the sciences examinations. We expect that teachers will use these data to reflect on the areas of the program that their students did well in and those areas where student performance was poor.

Annual Report

An annual report that summarizes results from the January, June, and August diploma examination administrations is released in the fall of each year. The purpose of this report is to inform educators and the public about student achievement in relation to provincial standards.

SUBJECT-SPECIFIC INFORMATION

BIOLOGY 30

Standards

Students of Biology 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of biological concepts by their increased ability to apply these concepts to relevant situations and to communicate in the specialized language of biology.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, and in particular by the successful completion of Biology 10 and Biology 20.

Students who attain an *acceptable* standard of performance in Biology 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific investigation by designing and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs and tables, and can translate symbolic representations of biological functions into word descriptions. They can readily recognize and provide definitions for key biological terms. They know the general properties of key biological substances. These students can demonstrate an acceptable level of understanding of biological concepts by tracing the pathways that materials follow as they are transported through human organ systems, by sequentially ordering the major steps of a physiological process, and by formulating simple structural and functional comparisons among components of human organ systems. They can relate human physiological concepts to common everyday experiences, but they may have difficulty relating these concepts to health problems. These students can compose clear and logical descriptive or explanatory statements about major human physiological concepts.

Students who attain a standard of *excellence* in Biology 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate their ability and interest in biology and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. When presenting scientific data, they select the most appropriate form. These students can analyze and evaluate experimental designs. They can easily identify significant parts of human organs and can describe their functions clearly and accurately. They can analyze human physiological problems that involve several interrelated steps, and they can form inferences from extracurricular data that are provided with the problems. These problems would most likely involve regulatory feedback loops and/or a minimum of two interacting human organ systems. Exceptional students can communicate clearly and concisely, using appropriate scientific vocabulary, and can write multiparagraph compositions.

Structure of the 1994 Examinations

Each Biology 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

Content

The 1994 Biology 30 diploma examinations have the following approximate emphases on core concepts:

Concept[1]	Per Cent Emphasis
• Cellular Processes	9
• Homeostatic Mechanisms	4
• Nutrition and Digestion	16
• Body Fluids	15
• Breathing, Gas Exchange, and Transport	7
• Energy Release	5
• The Kidney	10
• Regulation of the Internal Environment	20
• Voluntary Movement and Body Support	4
• Human Reproduction	10

Design

The design of the 1994 Biology 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Per Cent Emphasis*
Multiple Choice	70	70
Written Response	4	30

Note: The machine-scored section of the examination consists of multiple-choice questions only. It does not include diagram-matrix matching questions as anticipated when the 1992-93 *Biology 30, Chemistry 30, Physics 30 Bulletin* was prepared.

Examination Specifications

The cognitive levels[2] of Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation are addressed throughout the examination. Each cognitive level has the following emphasis:

Multiple Choice	*Per Cent Emphasis*
Knowledge	25
Comprehension and Application	35
Analysis, Synthesis, and Evaluation	10

Written Response	*Per Cent Emphasis*
Comprehension, Application, Analysis, Synthesis, and Evaluation	30

Process skills are addressed throughout the examination, and in particular by one 10-mark question in the written-response section.

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

Emphases in the 1994 Examinations

- Some questions include contextual material that goes beyond the common scope of the core concepts as defined in the curriculum guide. The inclusion of these questions is not only appropriate but also necessary if application, analysis, evaluation are to be measured.

- Committees of teachers are encouraged to develop questions that address the broadest possible range of course objectives measurable by a paper and pencil test. This includes emphasizing an understanding of human physiology rather than rote memorization of human anatomy; integrating the main core concepts rather than treating each in isolation; relating the human organism to other life forms rather than treating it in isolation; and incorporating technological concepts, the nature of science, science and society issues, and historical perspectives if appropriate.

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[1] Concept descriptions have been shortened in this table.

[2] An explanation of cognitive levels is given in Appendix C.

- The marks allotted to the written-response section of the 1994 examinations are distributed among four questions. One of the four questions presents a synopsis of a research project, including pertinent data in the form of graphs and/or tables. The several parts of this question require students to demonstrate a variety of process skills. This composite question has a value of 10%.

  Another written-response question, also worth 10%, presents a clearly defined problem to which there are a number of different solutions. The problem is centred on biological concepts but includes one other component (technology, societal implications, or the nature of science). Students should be able to respond to this second component of the question by drawing on their general knowledge and science problem-solving experiences. This question also assesses students' written communication skills. Descriptive scales will be used to measure the three components of the students' responses. Marks will be allocated for the biology concepts, related technologies, and the written communication skills. A sample scoring guide for the communication skills component is as follows:

Score	***Scoring Descriptions***
(3)	The response is well organized and addresses the major points of the question fully. The student explains concepts clearly and logically, and demonstrates consistency of thought. The student uses complete sentences that make effective use of scientific vocabulary. When appropriate, the student uses suitable diagrams or sketches to illustrate written explanations.
(2)	The response addresses the major points of the question adequately. The student explains concepts in complete sentences that use some appropriate scientific vocabulary. Some organizational skills are evident.
(1)	The response addresses the major points of the question inadequately. The student explains concepts in complete sentences but does not consistently use appropriate scientific vocabulary. Organizational skills are not evident.
(0)	The response does not address even one of the major points of the question. The student uses inappropriate vocabulary, grammar, and/or sentence structure. The response requires several readings to abstract the sense.

The remaining two questions in the written-response section range in value from 4 to 6 marks. These questions are clearly defined contextual problems that have specific solutions based on the core concepts of the course. Student responses for each of these questions will be measured by using an analytical scoring guide.

Since no significant changes in question types will be introduced during 1994, the January 1993 and June 1993 Biology 30 diploma examinations and sample answers may be used as a source of sample type questions.

Validation of the Revised Biology 30 Course of Studies

During the 1993–94 school year, the revised Biology 30 course will be validated in pilot schools. These schools will also administer Biology 30 unit tests and year-end examinations prepared by the Student Evaluation Branch. Students who are registered in the Biology 30 pilot program will be exempt from writing Biology 30 diploma examinations. Their final course mark will be based entirely on the school-awarded mark.

Diploma Examinations for 1995

The development of Biology 30 diploma examinations for the revised Biology 30 Course of Studies will be based primarily on the field validation of items used on year-end examinations in the pilot schools. However, supplemental field tests may be prepared by the Student Evaluation Branch to be administered in the non-pilot schools.

For the 1995 diploma examinations, the per cent emphasis of machine-scored and teacher-scored questions will continue to be 70% and 30%, respectively. However, the machine-scored section may contain 48 multiple-choice items worth 48 marks and eight numerical-response items worth 8 marks, for 56 marks out of the total 80 marks for the examination. The teacher-scored section may contain four written-response items, two worth 8 marks each and two worth 4 marks each, for 24 marks out of the total of 80 marks for the examination.

Clarification of Word Usage in Examinations

In past examinations, a number of terms used in the context of scientific process skill questions have confused some students. A sample of such terms with their preferred definitions follows.

Hypothesis: A single proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect.

Conclusion: A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence.

Experiment: A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations.

Variable: A condition that can change in an experiment.
Variables in experiments are categorized as:

- **manipulated variables** (independent variables)—conditions that were deliberately changed by the experimenter.
- **fixed or restrained variables** (controlled variables)—conditions that could have changed but did not, because of the intervention of the experimenter.
- **responding variables** (dependent variables)—conditions that changed in response to the change of the manipulated variables.

For additional clarification of the specialized terms used to describe science process skills, see Al Gibbs, Anton E. Lawson, *The Nature of Scientific Thinking As Reflected by the Work of Biologists & by Biology Textbooks*, The American Biology Teacher, March 1992, Volume 54, Number 3, page 137.

Technology: The development of our understanding of human physiology is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology includes both these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

Directing Words: Students are advised to review the meaning of directive words as defined in Appendix E. These words will be used in the instructions given for responding to most items in the examinations, particularly in the written-response section.

CHEMISTRY 30

Standards

Students who attain an *acceptable* standard of performance but do not attain the standard of *excellence* in Chemistry 30 can state and solve numerous problems that require only a one-step solution. For example, they can derive a pH value from a given hydronium ion concentration or find the net voltage for a redox reaction by using the data booklet. These same students would experience difficulty with multiple-step problems such as finding the pH of a partially neutralized mixture of an acid and a base. They are also unlikely to correctly answer questions involving concepts from more than one field of chemistry. They are capable of balancing an equation (combustion, formation, neutralization, or redox) and of solving the standard stoichiometric problems based upon these equations. Following the directions in laboratory procedures does not present a problem for these students, nor does drawing a graph from experimental data or reading values from the graph.

Students who attain a standard of *excellence* in Chemistry 30 should be well enough prepared to undertake successfully the next level of chemistry, whether it be at a university, a technical school, or a nursing school. These students can create their own laboratory procedures when given a clear definition of a problem. They can recognize weaknesses in laboratory work and can find ways to correct the weaknesses. These students can write their own equations for formation, combustion, neutralization, and redox reactions, and can solve many variations of stoichiometric problems based upon these equations. They are able to transfer what they see happening in a test tube into equation form and are able to express scientific ideas clearly. They can extract valid inferences from graphical data. They can usually cope with problems that involve overlapping of two or more concepts. The most significant characteristic of this group is that they can solve problems of a new and novel nature and can extrapolate these solutions to higher levels of understanding. These students usually possess good communication skills and can extract vital information from laboratory data or from word problems.

Structure of the 1994 Examinations

Each Chemistry 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

Content

The 1994 Chemistry 30 diploma examinations have the following approximate emphases on core concepts:

Concept[1]	*Per Cent Emphasis*
• Chemical Energetics	32
• Acids and Bases	34
• Oxidation-Reduction	34

Design

The design of the 1994 Chemistry 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Per Cent Emphasis*
Multiple Choice	42	60
Numerical Response	7	10
Written Response	3	30

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[1] Concept descriptions have been shortened in this table.

Examination Specifications

The cognitive levels[2] of Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation are addressed throughout the examination. Each cognitive level has the following emphasis:

Machine Scored	*Per Cent Emphasis*
Knowledge	30
Comprehension and Application	30
Analysis, Synthesis, and Evaluation	10
Written Response	
Comprehension, Application, Analysis, Synthesis, and Evaluation	30

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

Emphases in the 1994 Examinations

- We will continue to evaluate written-response questions on how well the answer is communicated.

- Some questions will include concepts from more than one of the core concepts.

- Written-response questions will require students to see relationships among concepts learned.

- Some questions will require students to apply what they learned in new contexts.

- Written-response questions may require students to write balanced chemical reaction equations including correct states of matter.

- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the calculator.

- The diploma examination treats the terms "oxidation number" and "oxidation state" as synonyms. It has come to our attention that some resource materials are making an artificial and false distinction between these terms.

- The diploma examination will continue to examine the concept "electrochemical cells" as defined in the existing program of studies. However, allowances will be made for students using resources approved for the new *Program of Studies.*

Changes to the Field Tests

Field test for students currently enrolled in the present program of studies will ***only*** contain questions common to both the present and future program of studies and they will use the current green data booklet.

Students involved in validating the new program of studies will have field tests containing questions that **only** reflect the new program. These students will use a red draft data booklet.

Calculators

The only student programmed function allowed is the quadric equation. All others are viewed as electronic notes (see Appendix B of this bulletin).

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[2] An explanation of cognitive levels is given in Appendix C.

Communications Assessment of Written Responses

The intent of evaluating communication is to reward students for creating responses that are on topic, clear, concise, and well written using the conventions of scientific language. Communication assessment on the chemistry diploma examinations will focus on three main criteria.

First, the response must address the question asked and appropriately apply concepts learned in Chemistry.

Secondly, the response must be expressed clearly and logically, and organized in a meaningful manner.

Thirdly, the response must use conventions of scientific language accurately.

Markers of the 1993 Chemistry 30 diploma examinations made the following comments about communication:

- "Shorthand" should not be used for written responses because there is no guarantee that a specific teacher's/student's shorthand notation will be understood by all markers.

- The "box" method of stoichiometry is **not** an acceptable method of communicating an answer and should not be used in the written-response section of the examination.

- Proper terminology should be used. For example, pH not Ph, molar heat (enthalpy) of reaction not reaction heats, etc.

Validation of the Revised Chemistry 30 Curriculum

During the 1993–94 school year, the revised Chemistry 30 curriculum will be validated in pilot schools. These schools will also administer Chemistry 30 unit tests and year-end examinations prepared by the Student Evaluation Branch. Students who are registered in the Chemistry 30 pilot program will be exempt from writing Chemistry 30 diploma examinations. The final course mark will be based entirely on the school-awarded mark.

Diploma Examinations for 1995

The development of Chemistry 30 diploma examinations for the revised Chemistry 30 Course of Studies will be based primarily on the field validation of items used on year-end examinations in the pilot schools. However, supplemental field tests may be prepared by the Student Evaluation Branch to be administered in the non-pilot schools.

For the 1995 diploma examinations, the per cent emphasis of machine-scored and teacher-scored questions will continue to be 70% and 30%, respectively.

PHYSICS 30

Standards

Students who attain an *acceptable* standard of performance and do not attain the standard of *excellence* in Physics 30 can state and solve problems that can be related quickly to an equation in the data booklet. Their laboratory skills are limited to following explicit directions and to using laboratory data to verify known physics information. These students are capable of defining and calculating quantities such as slope, refractive index, orbit radius, electric force, and photoelectric work function. They tend to use item-specific methods in their problem solving and rarely use the major generalizations of physics such as Newton's Laws or the conservation laws of charge, momentum, and energy. These students rely heavily on the equations provided in the data booklet and often use such equations outside the equations' domain of validity.

Students who attain a standard of *excellence* in Physics 30 have demonstrated their ability and interest in both mathematics and physics and feel confident about their scientific abilities. These students should encounter little difficulty in post-secondary physics programs and should be encouraged to pursue careers in which they will utilize their talents in physics. Minor changes in problem format do not cause these students major difficulties. Students who attain a standard of *excellence* show far more flexibility and creativity than the average. They seek general methods and are not afraid to use conservation laws to solve an unusual problem. They transfer knowledge from one area of physics to another and can express their answers in clear and concise terms. In the laboratory, students who attain a standard of *excellence* can cope with data that are less than perfect or with instructions that are incomplete. They make inferences that are not part of the "known" parts of physics. In terms of concept development, they can make the distinction between vectors and scalars and between forces and fields. This group of students can also apply these distinctions to solve problems.

Structure of the 1994 Examinations

Each Physics 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

Content

The 1994 Physics 30 diploma examinations have the following approximate emphases on core concepts:

Concept[1]	*Per Cent Emphasis*
• Nature and Behavior of Light	25
• Electric and Magnetic Fields	25
• Electromagnetic Radiation	15
• Structure of Matter	20
• Modern Physical Theories	15

Design

The design of the 1994 Physics 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Per Cent Emphasis*
Multiple Choice	42	60
Numerical Response	7	10
Written Response	4	30

Examination Specifications

The cognitive levels[2] of Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation are addressed throughout the examination. Each cognitive level has the following emphasis:

Machine Scored	*Per Cent Emphasis*
Knowledge	25
Comprehension and Application	35
Analysis, Synthesis, and Evaluation	10

---

[1] Concept descriptions have been shortened in this table.

[2] An explanation of cognitive levels is given in Appendix C.

Written Response	***Per Cent Emphasis***
Comprehension, Application, Analysis, Synthesis, and Evaluation	30

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

Emphases in the 1994 Examinations

- Some questions require the synthesis of concepts from more than one of the core concepts. In addition, some questions include contextual material that goes beyond the common scope of the core concepts as defined in the curriculum guide. The inclusion of these questions is appropriate and necessary to measure higher cognitive skills.
- All written-response questions involving calculations require students first to state an explicit formula statement from the data booklet and, secondly, to explicitly provide the substituted values.
- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the calculator.
- Routine calculations based on the equations in the data booklet will be limited to 30% of the examination.
- The 21 marks allotted to the written-response section of the 1994 examinations are distributed among four open-ended questions. One open-ended question is worth approximately 10% of the examination. This question will integrate various concepts covered in the Physics 30 course and will test students at comprehension, application, and cognitive levels.

Numerical-Response Questions in the 1994 Diploma Examinations

- The Physics 30 diploma examinations have included a numerical-response section for the past two years. These seven machine-scored questions involved routine calculations and were classified as predominantly comprehension and application. Each question specified the number of digits required in the answer.
- Generally, students followed the instructions quite well. However, some students consistently rounded their answers to the incorrect number of digits. This may be a result of students simply writing their answers from their calculators rather than rounding only the final answer. A few students counted the decimal point as a digit or filled in the zero bubble instead of the decimal bubble. Teachers should emphasize that students need to read the instructions carefully before making an entry on the answer sheets and to take great care that their answers are recorded in the appropriate spaces.

Scoring the Written Response

The written-response questions will be evaluated in terms of students' ability to communicate the appropriate physics concepts. Students demonstrating good scientific communication skills show respect for the conventions that are appropriate to the science. In physics, these conventions typically include labeling and scaling axes, selecting appropriate equations, substituting values, using appropriate units and significant digits, and organizing the solution. Written responses will also be assessed on the basis of conventions for good scientific writing. A suggested scheme for awarding the communication skills mark follows.

Written Communication Skills—Scoring Guide

Score	*Scoring Description*
(3)	• response integrates experimental observations and physics principles • response shows that the full scope and sequence of the problem has been correctly addressed • concepts are clearly and logically explained with consistency of thought • cause/effect relationships are consistently evident • scientific vocabulary is used appropriately • precise, explicit relationship between explanation and diagrams (if used)
(2)	• response attempts to integrate experimental observations and physics principles, but may falter. • response attempts to answer the full scope and sequence of the problem but may not be completely successful • concepts are explained with some inconsistency of thought • cause/effect relationships may/may not be consistently evident • scientific vocabulary if attempted is not always appropriately used • imprecise, explicit relationship and/or implicit relationship between explanation and diagrams (if used)
(1)	• response does not integrate experimental observations and physics principles • response does not answer the full scope and sequence of the problem • concepts explained show little or no consistency of thought • cause/effect relationships are not consistently evident • scientific vocabulary, if attempted, is used inappropriately • weak relationship between explanation and diagrams (if used)
(0)	• no attempt to integrate experimental observations and physics principles • communication is confusing and/or frustrating to the reader • too little has been written to assess the quality of the communication • unlabelled diagram

An alternative format of the above scoring descriptions is provided on the next page.

Markers of the June 1993 Physics 30 Diploma Examination adapted the Communication Skills Scoring Guide found on the previous page and developed the scoring matrix presented below. Many found the matrix useful when assessing students' communication skills.

Written Communication Skills — Scoring Matrix

Score	Integration of Experimental Observations and Physical Principles	Scope and Sequence of Problem	Explanation of Concepts	Cause/Effect Relationships	Scientific Vocabulary	Relationship between Explanation and Diagrams (if used)
(3)	correct	fully, correctly addressed	clear, logical, consistent	consistently evident	used appropriately	precise, explicit
(2)	attempts/may falter	attempted with some success	some inconsistencies	may or may not be consistently evident	if attempted, is not always appropriately used	imprecise and explicit OR implicit
(1)	weak attempt	not complete	little or no consistency	not consistently evident	if attempted, is used inappropriately	weak
(0)	no attempt	confusing and/or frustrating	confusing and/or frustrating	confusing and/or frustrating	too little written to assess quality	unlabelled diagrams

Validation of the Revised Physics 30 Curriculum

During the 1993–94 school year, the revised Physics 30 curriculum will be validated in pilot schools. These schools will also administer Physics 30 unit tests and year-end examinations prepared by the Student Evaluation Branch. Students who are registered in the Physics 30 pilot program will be exempt from writing Physics 30 diploma examinations. The final course mark will be based entirely on the school-awarded mark.

Diploma Examinations for 1995

The development of Physics 30 diploma examinations for the revised Physics 30 Course of Studies will be based primarily on the field validation of items used on year-end examinations in the pilot schools. However, supplemental field tests may be prepared by the Student Evaluation Branch to be administered in the non-pilot schools.

For the 1995 diploma examination, the per cent emphasis of machine-scored and teacher-scored questions will continue to be 70% and 30%, respectively. However, the machine-scored section may contain 35 multiple-choice items worth 35 marks and 14 numerical-response items worth 14 marks, for 49 marks out of the total 70 marks for the examination. The teacher-scored section may contain four written-response items, for 24 marks out of the total of 70 marks for the examination.

SCIENCE 30

Course Validation and Implementation

The Science 30 Course of Studies will be validated in pilot schools during 1993–94 and in all provincial schools that choose to offer it in 1994–95. During these two school years, Science 30 students will be exempt from writing Science 30 diploma examinations. Their final course mark will be based entirely on the school-awarded mark. However, 2.5 hour year-end examinations will be provided by the Student Evaluation Branch during January and June of each course validation school year. Science 30 teachers are asked to use students' achievement on these year-end examinations in the determination of their school-awarded marks.

A time for writing these Science 30 year-end examinations has been arranged during the regular diploma examination schedule. Please administer during the following times:

Tuesday, Jan. 25, 1994	1:00 to 3:30 p.m.
Friday, June 24, 1994	1:00 to 3:30 p.m.

Note: The Science 30 year-end examinations are designed as 2.5 hour examinations. It is expected that this is adequate time for students to finish. However, for those students who need it, an extra 0.5 hour is available.

Standards

Students who attain an *acceptable* standard of performance in Science 30 can state or solve multi-step problems. They are able to correctly answer questions involving concepts from a particular area of science. These students are able to follow correct laboratory procedures when given specific directions. They can make the connection between science concepts and laboratory activities when the data are used to verify known information. Drawing a graph from experimental data or reading values from a graph does not present a problem for these students. They can use science knowledge to explain the operation of various technologies studied in Science 30. They are also able to present arguments about societal issues such as environmental concerns and ethical issues related to Science 30 material.

Students who attain a standard of *excellence* in Science 30 have gained knowledge and abilities that allow them to be literate in a broad range of science areas. Such students can integrate concepts from many areas of science. They demonstrate creativity and flexibility and can solve multi-step problems. They are able to design or refine laboratory procedures to demonstrate science principles or solve science problems. They can critically analyze scientific studies, including the associated charts, graphs, and conclusions. These students are aware of the variety of viewpoints relating to the environmental and ethical issues in the field of science and technology. They are able to clearly express their opinions about these issues.

Structure of the 1994 Year-End Examinations

Each Science 30 Diploma Examination will be designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination will be limited to those objectives that can be measured by a paper and pencil test.

Content

The 1994 Science 30 year-end examinations will concentrate on outcomes that demonstrate that the student can:

- show how the body maintains equilibrium with its *environment* through the interaction of the nervous, circulatory, and immune systems.
- show the role of DNA in maintaining equilibrium.
- classify and describe systems (categories) of matter including acids, bases, and organic compounds based on their chemical characteristics and their impact on the *environment*.
- demonstrate a knowledge of the diversity (similarities and differences) in the properties of gravitational, electrical and magnetic fields.
- demonstrate an understanding of the properties of the electromagnetic spectrum (energy), including their use in studying the history and structure of the universe.
- demonstrate an understanding of the sources of usable energy and the environmental impacts of various systems (forms) of energy production and use.

Design

The design of the 1994 Science 30 year-end examinations will include multiple-choice, numerical-response, and written-response questions.

Emphases in the 1994 Year-End Examinations

- Most questions will include contextual material. In some cases, a series of questions will be developed around a single scenario. This will reduce the amount of text necessary for each question. It will also lead to an integration of questions from all the units of the course.

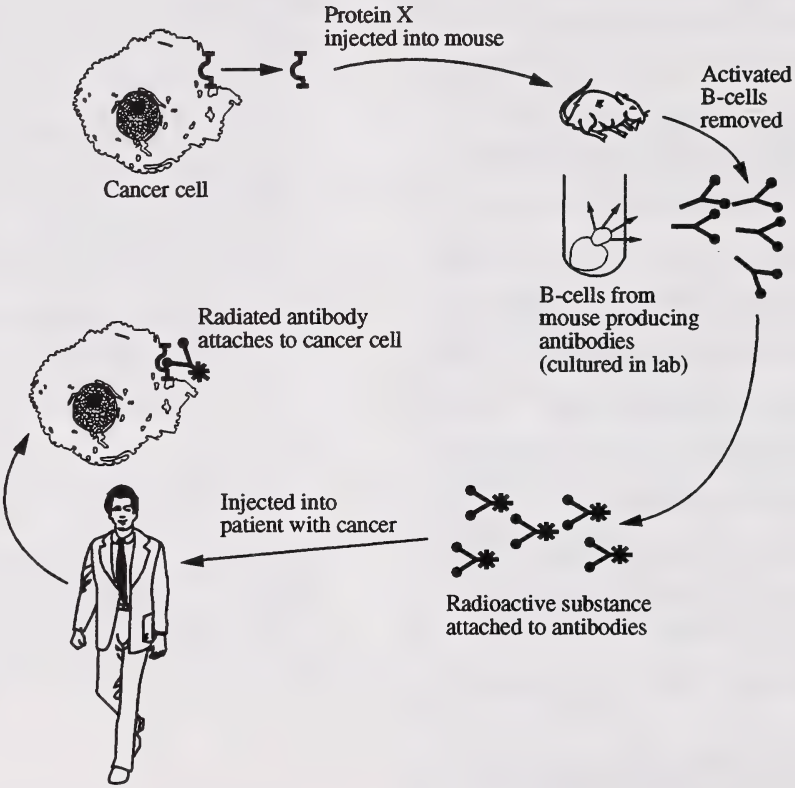
- The emphasis of the written-response section will be 30% of the total examination mark, which will be distributed among three or four questions. These questions will have an emphasis on technological concepts and the nature of science, along with science and society issues. They will require students to outline and defend positions on STS issues or describe technologies of their own choosing. Because of the "open-endedness" of these questions, descriptive scales will be used to mark student responses.

Sample Questions

This diagram will help you answer questions 1, 2, and 3.

Fighting Disease with Biotechnology

In the mid seventies scientists devised a method for producing antibodies outside of the body. First a mouse is injected with a specific target – protein X. The mouse's B–cells begin to produce an antibody to the foreign molecule. These B–cells are then taken from the mouse and cultured in the lab where they continue to produce the desired antibody.



1. In the mouse, protein X acts as a(an)

   A. antigen
   B. immune suppresser
   C. agglutinin
   D. self chemical

Use the additional information to answer questions 2 and 3.

Recently a researcher used this method to produce antibodies against a certain type of cancer cell. The antibodies attached to the cancer cells but were ineffective in killing them. The researchers discovered a method of attaching a radioactive substance to the antibodies. When these antibodies where injected into the cancer patients they attached to the cancer cells exposing them to radiation. Remission rates and cure rates were higher with this treatment than with other treatments.

2. Some of the factors to be considered when evaluating this method of treatment are

I. radiation is delivered to specific cells
II. radiated antibodies can be recovered after use
III. extent of cancer can be determined more easily
IV. antibodies originate from the patient

Advantages of this treatment are

A. I and III
B. I and IV
C. I, III, and IV
D. II, III, and IV

3. A disadvantage of this procedure is most likely that

A. the radiated antibodies will be treated as antigens by the patient's immune system
B. the radiated antibodies will attack the patient's own immune system
C. higher levels of radiation will be required than with traditional radiation therapy
D. the radiation will cause damage to healthy cells since it is not targeted specifically

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4. The term "sustainable development" is commonly used when talking about the relationship among politics, economics, and the environment. Some people use this term to assert that we can simultaneously achieve continued economic growth and improved environmental protection. The following diagram helps to illustrate the relationship that might exist along a continuum of deep ecology to unbridled economic expansion.

DEEP ECOLOGY (SUSTAINABILITY VALUES AS DOMINANT	--------	SUSTAINABLE DEVELOPMENT	--------	UNBRIDLED ECONOMIC EXPANSION (DEVELOPMENT VALUES AS DOMINANT)

<-->

According to this definition of sustainable development (there are over 70 other definitions), are *improved* environmental protection and *continued* economic growth possible at the same time? In your answer, provide examples of a deep ecology point of view and an economic expansion point of view for a particular environmental issue. Also, include the roles of science, technology, and society in your answer.

Score	***Scoring Descriptions***
(4)	The answer states the point of view that is being defended. An environmental issue is presented that demonstrates both sustainability and development values. Examples of STS solutions are given, and their strengths and weaknesses are described. The answer reflects an in-depth understanding of environmental/ economic conflict at a global level.
(3)	The answer states the point of view that is being defended. An environmental issue is presented that demonstrates both sustainability and development values. Examples of STS solutions are given. The environmental/economic growth conflict is represented but is specific rather than global in scope.
(2)	The answer states the point of view that is being defended. An environmental issue is described that adequately demonstrates either sustainability or development values. Examples of STS solutions are given. The answer demonstrates an understanding that there is a conflict between economic growth and environmental concerns.
(1)	The answer demonstrates that there is a conflict between economic growth and environmental concerns but does not clearly state the point of view being defended. Examples are absent or have limited application to the discussion.
(0)	The answer does not demonstrate the conflict between economic growth and environmental concerns.

Appendix A

Policy: Use of Calculators on Alberta Education Diploma Examinations

Background

The knowledge, skills and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics, chemistry, and physics does not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics, chemistry, and physics. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. At the beginning of a course, teachers must advise students of the calculators that may be used when they are writing mathematics, chemistry, and physics diploma examinations.

2. In preparation for calculator failure, students may bring extra calculators and batteries into the exam.

3. During exams, supervising teachers must ensure that
   a. all calculators fall within the definition provided with this policy,
   b. all calculators operate in silent mode,
   c. students do not share calculators,
   d. students do not bring external devices to support calculators into the examination room. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

Appendix B

Examination Rules, Grade 12 Diploma Examinations

1. **Admittance to the Examination Room**
   Students must not enter or leave the examination room without the consent of the supervising teacher.

2. **Student Identification**
   Students must present identification that includes their signature and photograph. One of the following documents is acceptable: driver's licence, passport, or student identification card. Students must not write an examination under a false identity or knowingly provide false information on an application form.

3. **Identification on Examinations**
   Students must not write their names or the name of their school anywhere in or on the examination booklet other than on the back cover.

4. **Time**
   Students must write an examination during the specified time and may not hand in a paper until at least one hour of the examination time has elapsed. Students who arrive more than one hour after an examination has started will not be allowed to write the examination. Students who arrive late but within the first hour of an examination sitting may be allowed to write only at the discretion of the supervising teacher.

5. **Discussion**
   Students must not discuss the examination with the supervising teacher unless the examination is incomplete or illegible. Students must not talk, whisper, or exchange signs with one another.

6. **Answer Sheets**
   Students must use an HB pencil to record their answers on the machine-scorable answer sheets.

7. **Written Responses**
   All work for the written-response sections of the diploma examinations must be done in the examination booklet. Students are expected to write their revised work in blue or black ink for English 30, English 33, Français 30, Social Studies 30, and Biology 30.

8. **Material Exchanges**
   Students must not copy from other students or exchange material. Notes in any form–including those on papers, in books, or stored in electronic devices–must not be brough into the examination room. Calculator programs designed to perform mathematical computations or those designed to assist students in graphing are not classified as notes.

9. **Material Allowed**
   English 30, English 33: Students may use a dictionary and a thesaurus for Part A only. Electronic devices are not allowed for either part.
   Français 30: Students may use a dictionary, a thesaurus, and a book of verb forms for Partie A only. Electronic devices are not allowed for either part.
   Social Studies 30, Biology 30: Students may not use electronic devices.
   Mathematics 30: Tear-out data pages are provided in the examination booklet. Students may use scientific calculators (see Calculator Policy, General Information Bulletin) but must not share them.
   Chemistry 30, Physics 30: A separate data booklet is provided for each of these examinations. Students may use scientific calculators (see Calculator Policy, General Information Bulletin) but must not share them.

   Students are expected to provide their own writing materials, including pens and HB pencils, calculators, or other necessary instruments. Tear-out pages for rough work are provided in each biology, chemistry, mathematics, and physics examination booklet.

10. **Translation Dictionaries**
    Students are not allowed to use translation dicitionaries in any subject. Exchange students must satisfy the same requirements as other students.

Appendix C

Explanation Of Cognitive Levels

Knowledge

Knowledge is defined as those behaviors and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena. This level comprises knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, methods of inquiry, principles and generalizations, and theories and structures.

Comprehension and Application

Comprehension refers to responses that demonstrate an understanding of the literal message contained in a communication. This means that the student is able to translate, interpret, or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves reordering ideas (inferences, generalizations, or summaries). Extrapolation is the ability to estimate or predict based on an understanding of trends or tendencies.

Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Analysis, Synthesis, and Evaluation

Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize a writer's viewpoint.

Synthesis is the production of a unique communication. It is the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as making judgments about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

Appendix D

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics, Chemistry, and Physics Diploma Examinations

Significant Digits

1. For all nonlogarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits,
   but a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   $$\begin{array}{rl} 12.3 & \text{(least precise)} \\ 0.12 & \\ \underline{12.34} & \\ 24.76 & \end{array}$$

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   $(1.23)(54.321) - 66.81483$

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, the answer should not be rounded off based upon interim values. For example:

   $(1.23)(4.321)/(3.45 - 3.21) = 22.145125$

   The answer should be rounded to 22.1.

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix E

Directing Words

Discuss

The word “discuss” will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity. It can mean to debate, i.e., present arguments both pro and con; to investigate, i.e., present in detail the factual information about a topic; or simply to talk about a subject.

The following words are more specific in meaning. The corresponding cognitive skills are enclosed in parentheses.

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures. (Analysis)

Compare

Show the character or relative values of two things by pointing out their *similarities* and *differences*. (Analysis and/or Evaluation)

Conclude

State a logical end based on reasoning and/or evidence. (Evaluation)

Criticize

Point out the *merits* and *demerits* of an item or issue. (Analysis and Evaluation)

Define

Provide the essential qualities or meaning of a word or concept. To make distinct and clear by marking out the limits. (Knowledge)

Describe

Give an account of in words; or represent by a figure, model, or picture the characteristics. (Knowledge)

Design/Plan

Construct a plan; i.e., detailed sequence of actions, for a specific purpose. (Application and/or Synthesis)

Enumerate

Specify one by one or list in concise form and according to some order. (Knowledge)

Evaluate

Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages. (Analysis and Evaluation)

Explain

Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail. (Comprehension)

How

Shown in what manner.

Hypothesize

Form a tentative proposition intended as a possible explanation for an observed phenomenon, i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically. (Analysis and Synthesis)

Identify

Recognize and select as having characteristics of. (Knowledge)

Illustrate

Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram. (Comprehension and/or Application)

Infer
Form a generalization from sample data; arrive at a conclusion by reasoning from evidence. (Evaluation)

Interpret
Tell the meaning of; present information in a new form that adds meaning to the original data. (Comprehension)

Justify/Show How
Show reasons for, or give facts that support a position. (Evaluation)

Outline
Give, in an organized fashion, the essential parts of. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps. (Knowledge and/or Comprehension)

Predict
Tell in advance on the basis of empirical evidence and/or logic. (Application)

Prove
Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons. (Evaluation)

Relate
Show logical or causal connection between. (Analysis)

Solve
Give a solution, i.e., explanation in words and/or numbers, for a problem. (Analysis and Synthesis)

Summarize
Give a brief account of the main points. (Comprehension)

Trace
Give a step-by-step description of the development of. (Knowledge)

Why
Show the cause, reason, or purpose for which. (Comprehension and/or Synthesis)

Appendix F

Preparing to Write a Science Diploma Examination—What every student should do before the examinations!

1. Prepare a course review schedule:
    - Design your schedule for the two-week period (minimum) before the examination
    - Divide the course material into sections and indicate on the schedule the time blocks to be devoted to each section
        - take into account the examination blueprint available from your teacher (*Diploma Examinations Program Information Bulletin* for the course). Note that course units are not equally weighted on the diploma examination
        - take into account units/concepts that you find most difficult; i.e., allocate more time for the review of these

2. Obtain and review examination schedules, rules, and policies:
    - Record the time and place of writing
    - note minimum and maximum writing times permitted
    - prepare to remain in the examination room for at least 2.5 h (Kleenex, cough drops, etc.)
    - identify materials allowed for writing each examination, such as pencils, pens, calculators, mathematical instruments, and clear plastic ruler

3. Identify and collect examples of each type of question that will be asked:
    - obtain a copy of the relevant information contained in the *Diploma Examinations Program Information Bulletin* for the course (available from your teacher)
    - review the format of previous diploma examinations (available from your teacher)
    - learn the meanings of key "directing" words such as compare, describe, evaluate, explain, illustrate, interpret, justify, prove, and solve

4. Make summaries and point form outlines:
    - distinguish between major concepts and factual details
    - identify essential skills that can be assessed on paper and pencil tests
    - review lab results and procedures – identify connections between lab reports, class notes, and textbook
    - anticipate examples of connections between concepts and the "real world"
    - prepare a glossary of important subject terminology
    - review the data booklet for Chemistry 30 or Physics 30, and review formulas and equations if applicable
    - link each formula or equation with a calculation done on a previous test or assignment
    - identify any restriction on the use of each formula or equation

5. Use memory aids such as:
    - color coding, underlining, highlighting, jotting keywords in margins
    - numbering points to be memorized
    - grouping word and idea associations
    - reading aloud key words, expressing key words in your own words

Appendix G

Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!

1. Do not be afraid to answer each question even if you are not sure of the correct solution to the problem. A penalty is NOT given for guessing on the machine-scored section the exam. Partial marks are often awarded for incomplete answers in the written-response section of the exam.

2. If you are stuck on a question, mark the alternatives that you know are incorrect and choose from the ones that are left using logical guessing strategy. Think of the questions as challenges and cultivate a positive attitude about your ability to answer them.

3. Scan the written-response, multiple-choice, and numerical-response sections of the examination before answering the questions. A question in one section of the examination may jog your memory about a question in another section.

4. When first reading a multiple-choice question, locate and circle key words to help clarify the meaning of the question. Then hide the alternatives and try to formulate an answer of your own. Your answer may be very close to the correct alternative.

5. If a multiple-choice question involves a calculation, do the calculation and select the alternative that is closest to your answer. A multiple-choice calculation is usually short. If you cannot do it in five minutes, your method is either inappropriate or incorrect. Go on.

6. Diagrams on examinations are often labeled with numbers or letters. It may be useful to write in the names of the labeled structures or features that you can identify.

7. When reading graphs, use a clear plastic ruler to more accurately extrapolate or interpolate data.

8. Have a good reason for changing an answer. Do not change an answer on a hunch. Do not waste your time looking for patterns of As, Bs, Cs, or Ds in multiple-choice answers. There are none.

9. You may not have time to write and edit a complete rough copy for each written-response question, but you should prepare an outline of your answer and use it as a guide when writing your good copy.

10. When completing a written-response question, keep in mind the reader of your response. The reader will want to know how well you:
    - understand the problem or the mathematical/science concept
    - can correctly use the mathematics involved
    - can use problem-solving strategies and explain your answer and procedures
    - can communicate your solutions and mathematical/science ideas

11. Rewriting a statement of the question is often a good way to begin a written response. Conclude with a summary statement. Be sure you have clearly explained all assumptions and have verified your conclusions.

12. Keep track of the time and pace yourself. Put a check mark by items that you are uncertain about and return to them if there is time at the end of the examination.

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